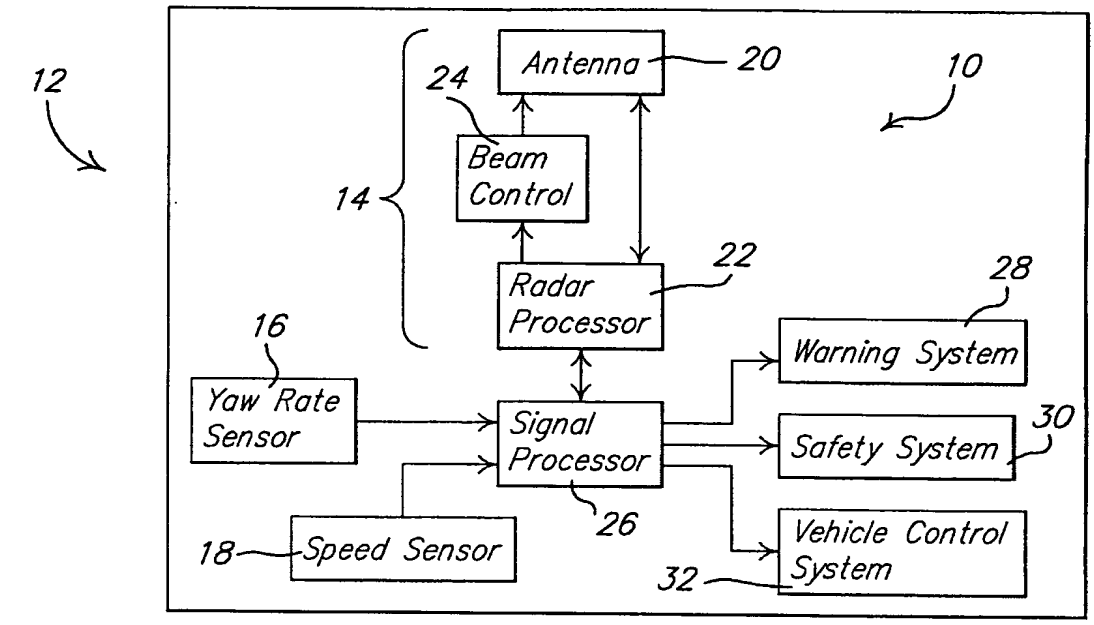

Fig. 1.

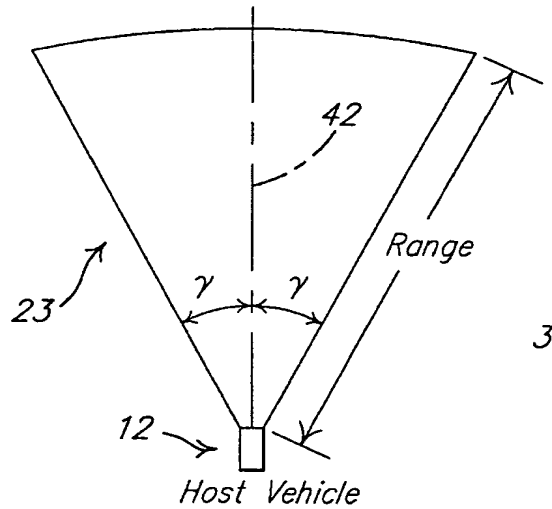

Fig. 2.

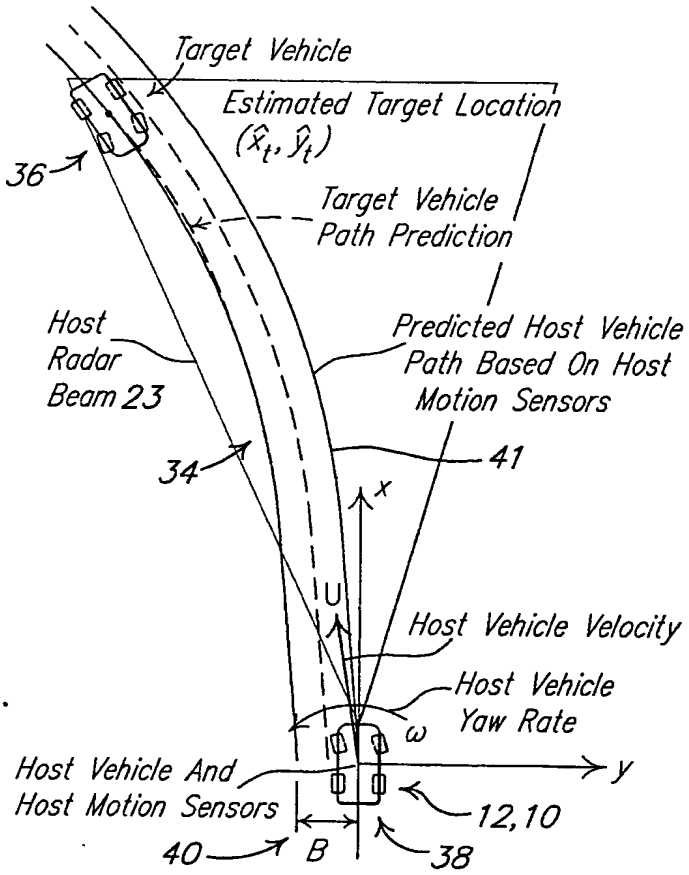

Fig. 3.

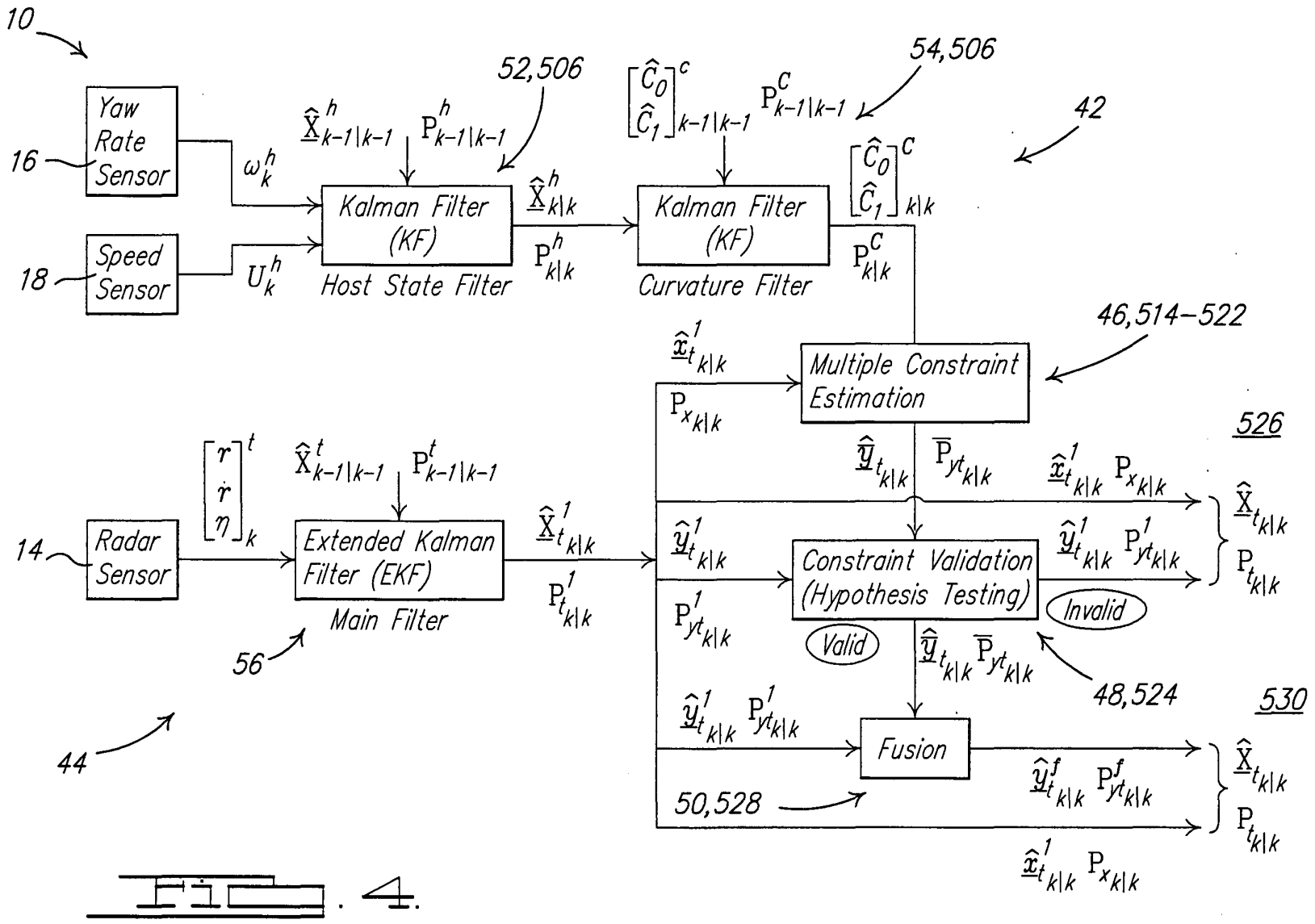
10
Yaw Rate Sensor
16
Speed Sensor
18
ω_k^h
U_k^h
$\hat{X}^h_{k-1|k-1}$
$P^h_{k-1|k-1}$
52,506
Kalman Filter (KF)
Host State Filter
$\hat{X}^h_{k|k}$
$P^h_{k|k}$
$\begin{bmatrix}\hat{C}_0\\ \hat{C}_1\end{bmatrix}^c_{k-1|k-1}$
$P^c_{k-1|k-1}$
54,506
Kalman Filter (KF)
Curvature Filter
$\begin{bmatrix}\hat{C}_0\\ \hat{C}_1\end{bmatrix}^c_{k|k}$
$P^c_{k|k}$
42
46,514–522
Multiple Constraint Estimation
$\hat{x}^1_{t_{k|k}}$
$P_{x_{k|k}}$
526
$\hat{y}_{t_{k|k}}$
$\overline{P}_{yt_{k|k}}$
$\hat{x}^1_{t_{k|k}}$ $P_{x_{k|k}}$
$\hat{X}_{t_{k|k}}$
$P_{t_{k|k}}$
$\hat{y}^1_{t_{k|k}}$
$P^1_{yt_{k|k}}$
Constraint Validation (Hypothesis Testing)
Valid
Invalid
$\hat{y}^1_{t_{k|k}}$ $P^1_{yt_{k|k}}$
$\hat{y}_{t_{k|k}}$ $\overline{P}_{yt_{k|k}}$
48,524
530
Fusion
$\hat{y}^f_{t_{k|k}}$ $P^f_{yt_{k|k}}$
50,528
$\hat{x}^1_{t_{k|k}}$ $P_{x_{k|k}}$
14
Radar Sensor
$\begin{bmatrix}r\\ \dot{r}\\ \eta\end{bmatrix}^t_k$
$\hat{X}^t_{k-1|k-1}$
$P^t_{k-1|k-1}$
Extended Kalman Filter (EKF)
Main Filter
56
$\hat{X}^1_{t_{k|k}}$
$P^1_{t_{k|k}}$
44

Fig. 4.

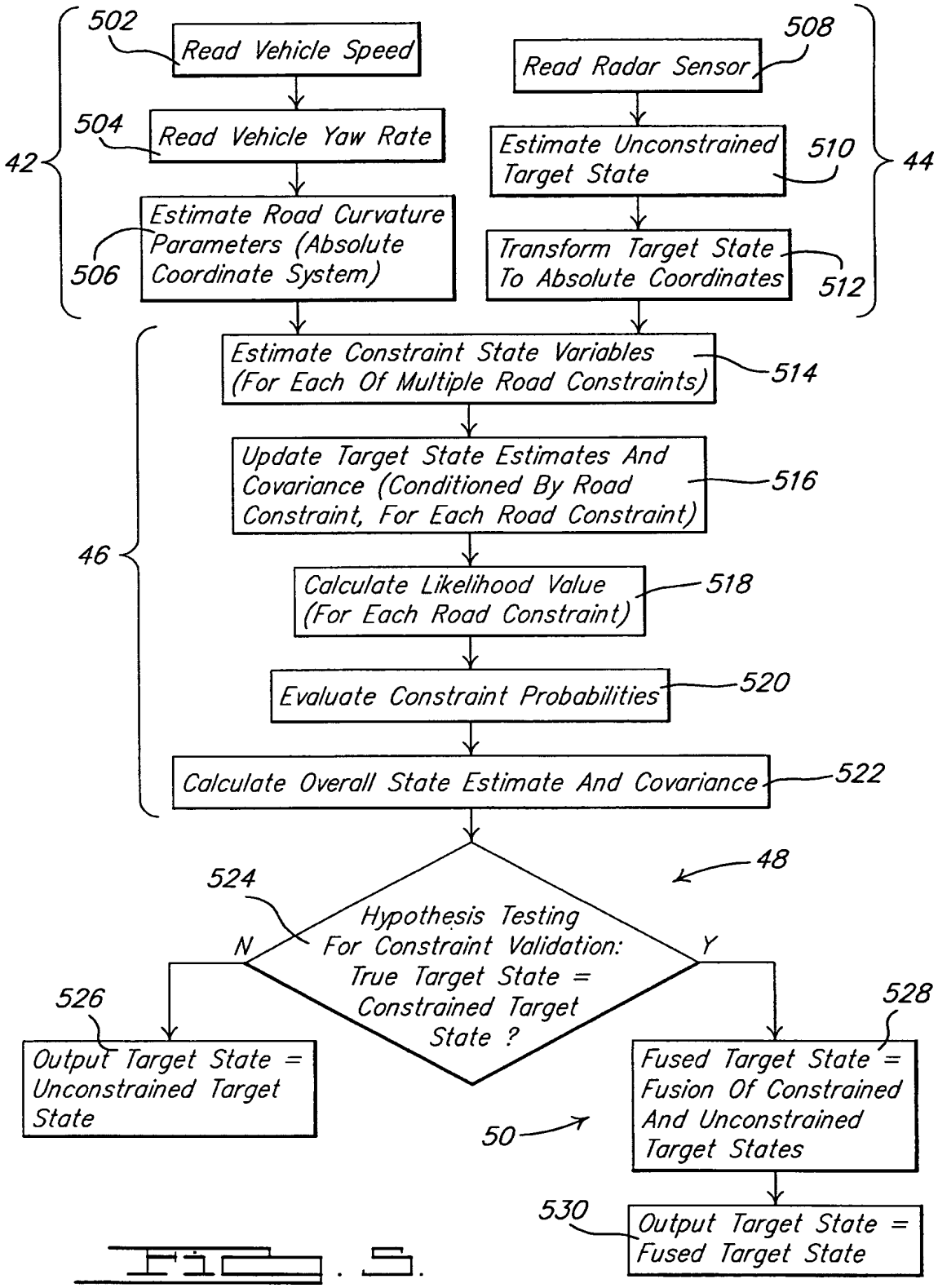
502
Read Vehicle Speed
504
Read Vehicle Yaw Rate
506
Estimate Road Curvature Parameters (Absolute Coordinate System)
42
508
Read Radar Sensor
510
Estimate Unconstrained Target State
512
Transform Target State To Absolute Coordinates
44
514
Estimate Constraint State Variables (For Each Of Multiple Road Constraints)
516
Update Target State Estimates And Covariance (Conditioned By Road Constraint, For Each Road Constraint)
46
518
Calculate Likelihood Value (For Each Road Constraint)
520
Evaluate Constraint Probabilities
522
Calculate Overall State Estimate And Covariance
48
524
Hypothesis Testing For Constraint Validation: True Target State = Constrained Target State ?
N
Y
526
Output Target State = Unconstrained Target State
528
Fused Target State = Fusion Of Constrained And Unconstrained Target States
50
530
Output Target State = Fused Target State

Fig. 5.

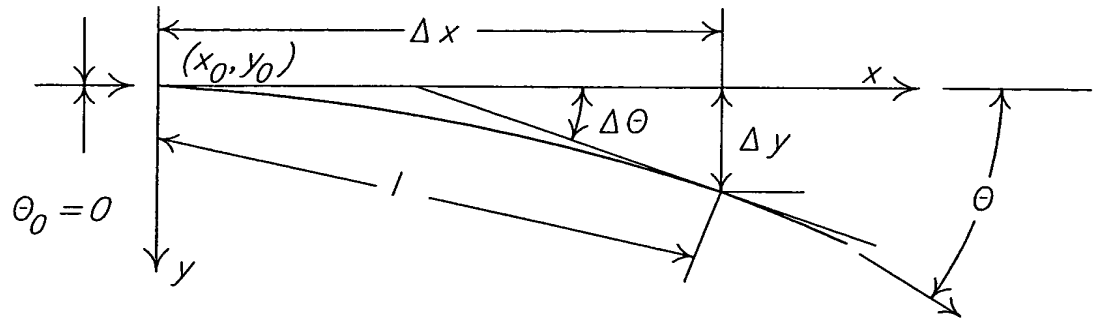

Fig. 6.

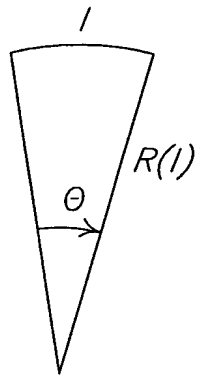

Fig. 7.

True, Measured & Estimated Target Trajectory

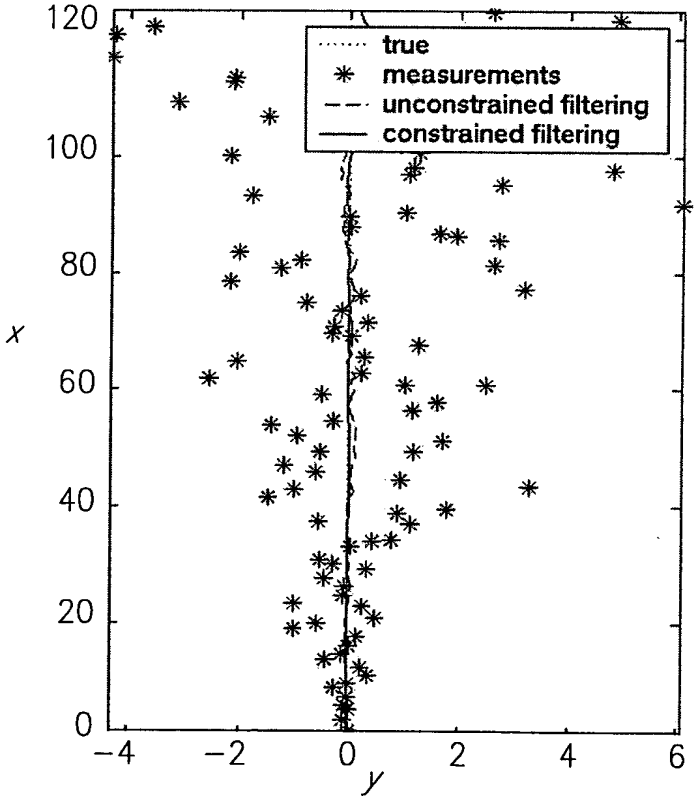

Fig. 8a.

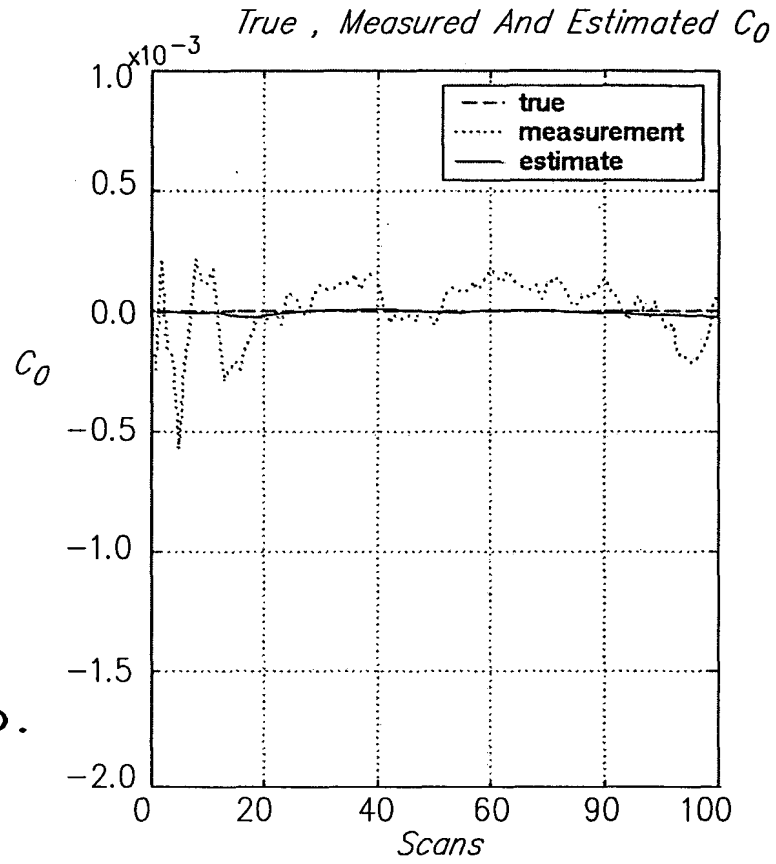
True , Measured And Estimated C_0
$\times 10^{-3}$
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
C_0
true
measurement
estimate
0
20
40
60
90
100
Scans

Fig. 3b.

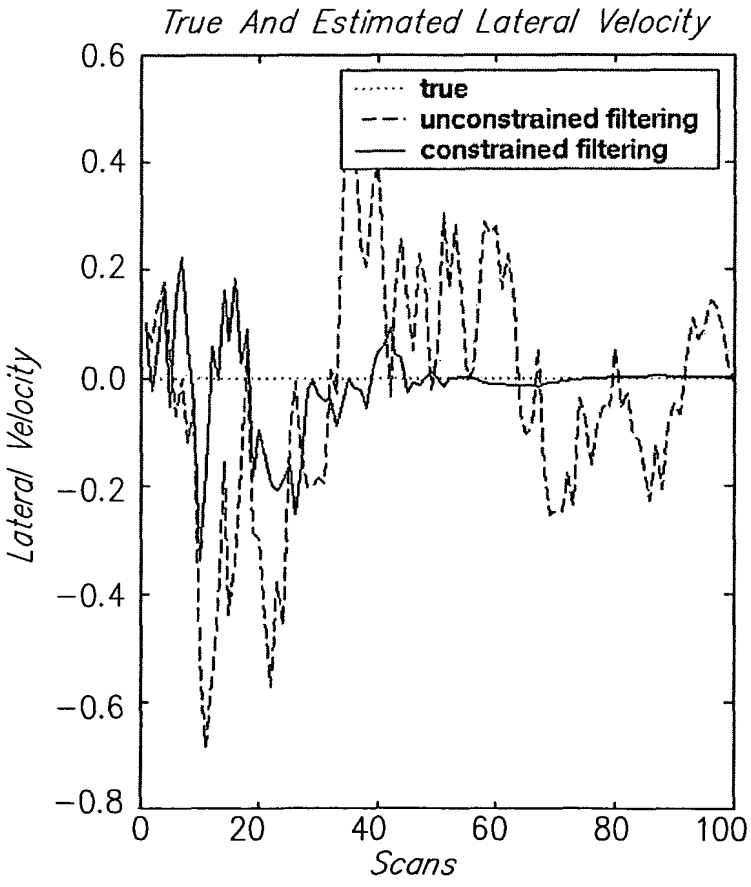
True And Estimated Lateral Velocity
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
Lateral Velocity
true
unconstrained filtering
constrained filtering
0
20
40
60
80
100
Scans

Fig. 3c.

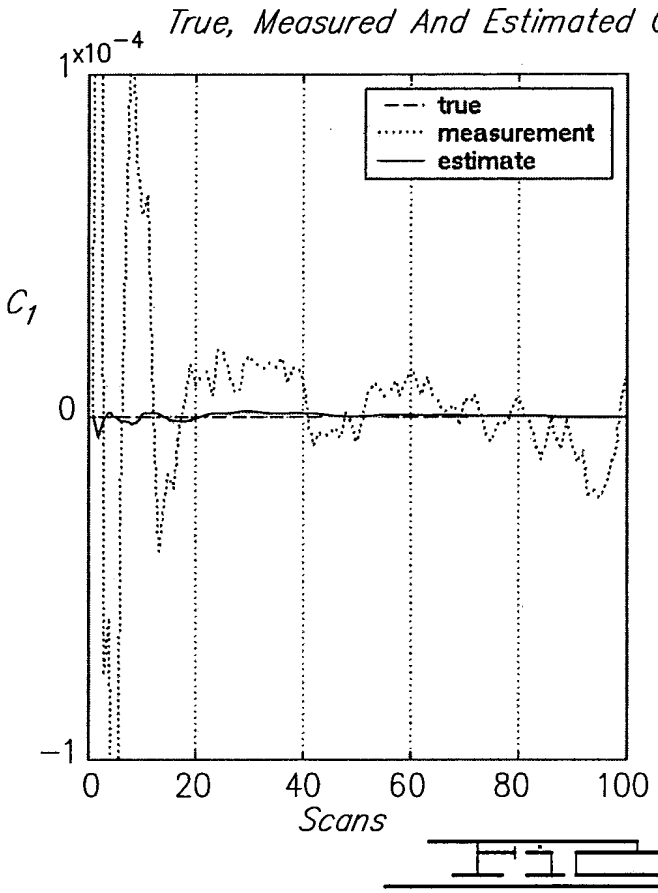
True, Measured And Estimated C_1
$1^{x10^{-4}}$
true
measurement
estimate
C_1
0
−1
0
20
40
60
80
100
Scans

Fig. 8d.

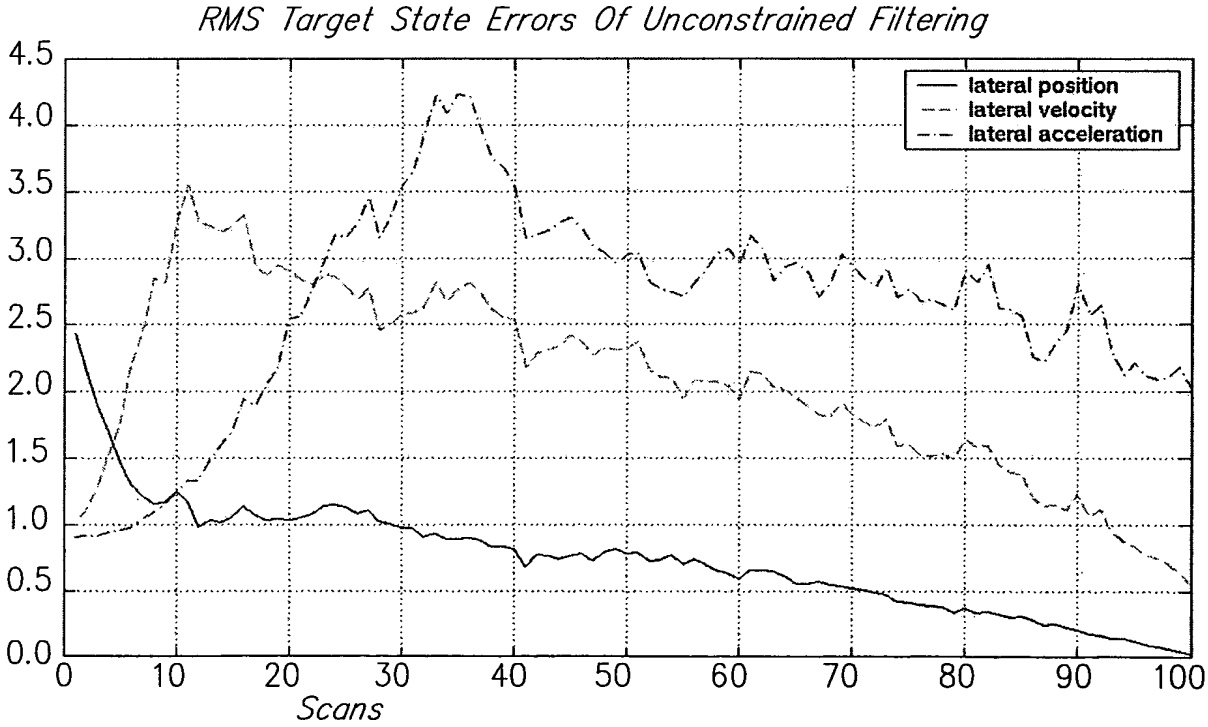
RMS Target State Errors Of Unconstrained Filtering
lateral position
lateral velocity
lateral acceleration
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
Scans

Fig. 8a.

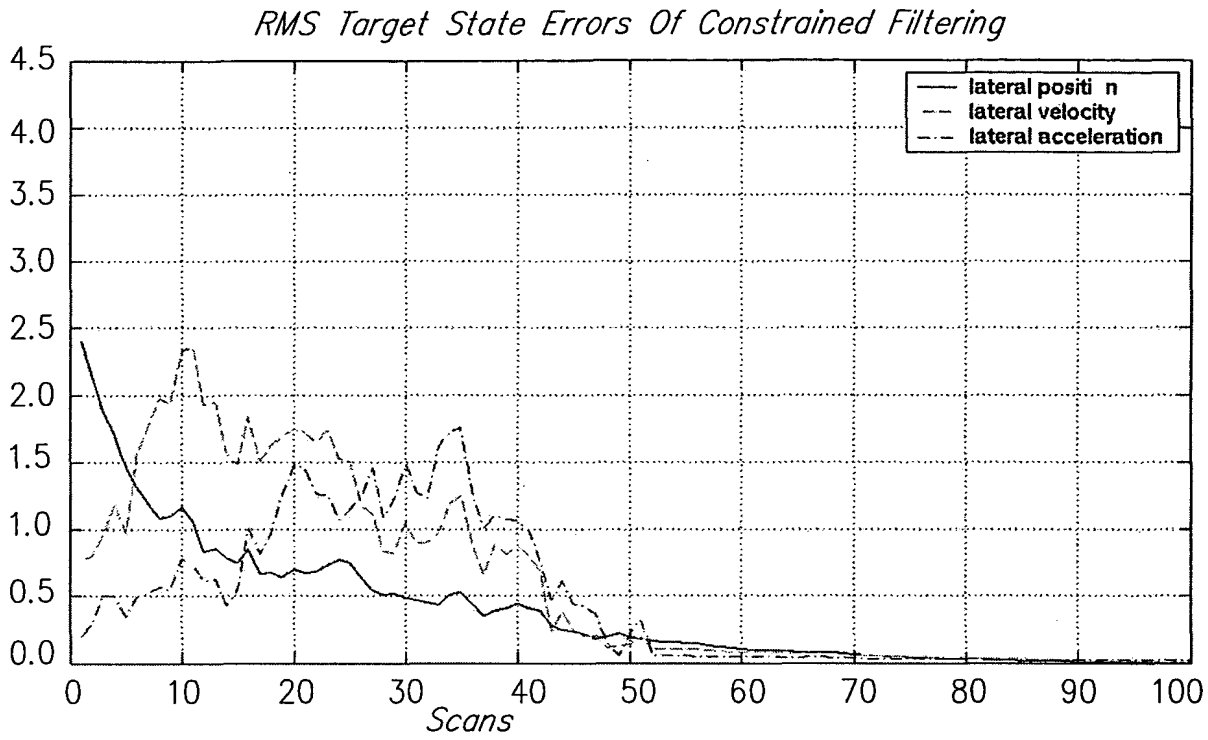

Fig. 9b.

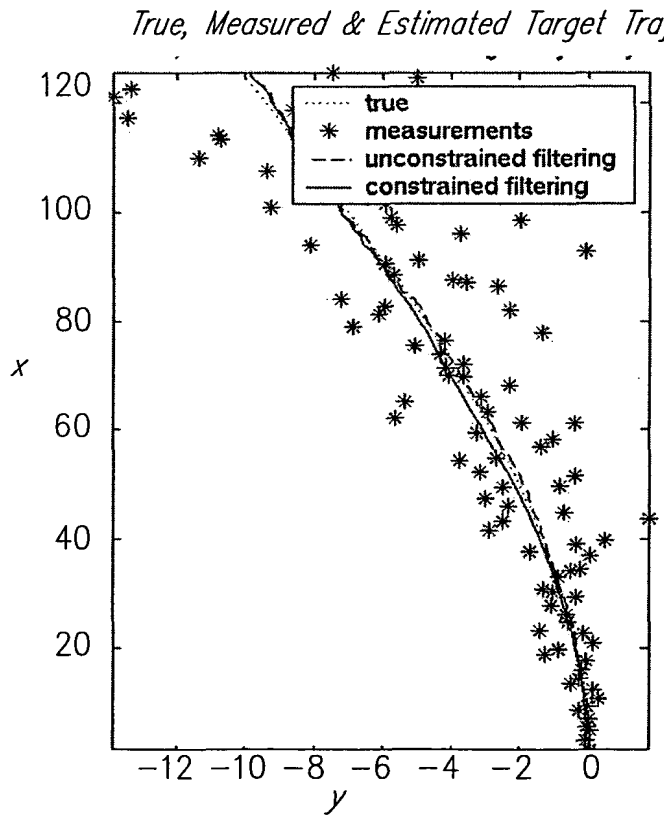

Fig. 10a.

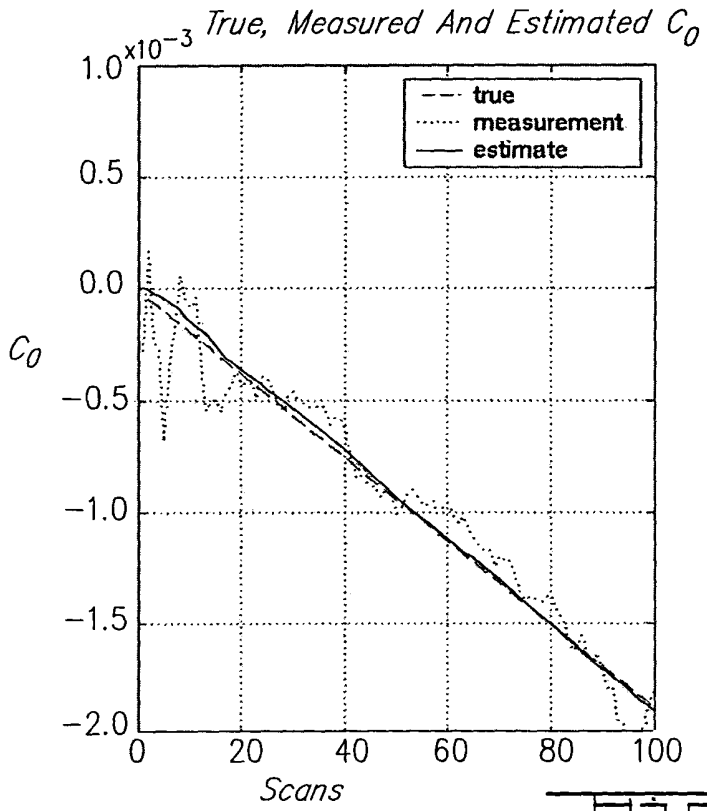

Fig. 10b.

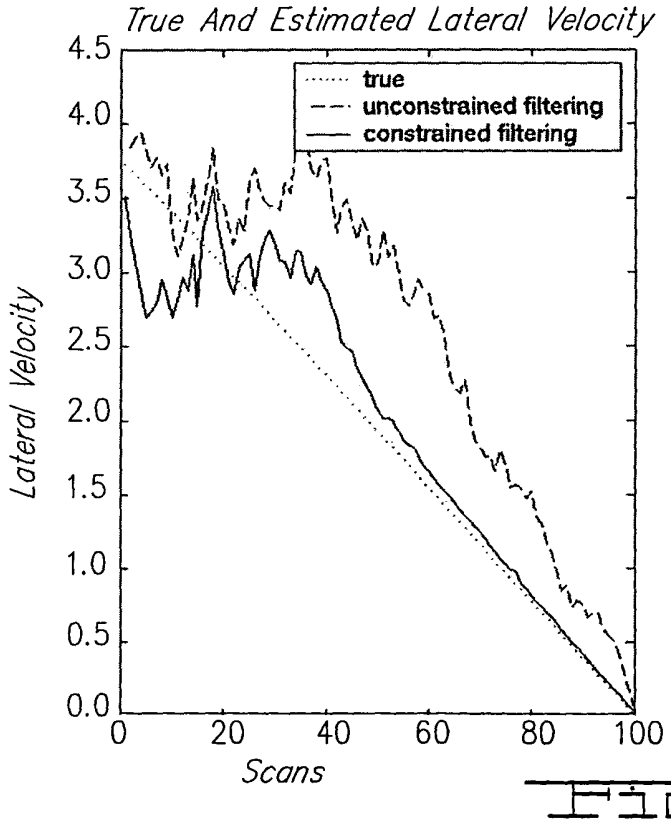

Fig. 10c.

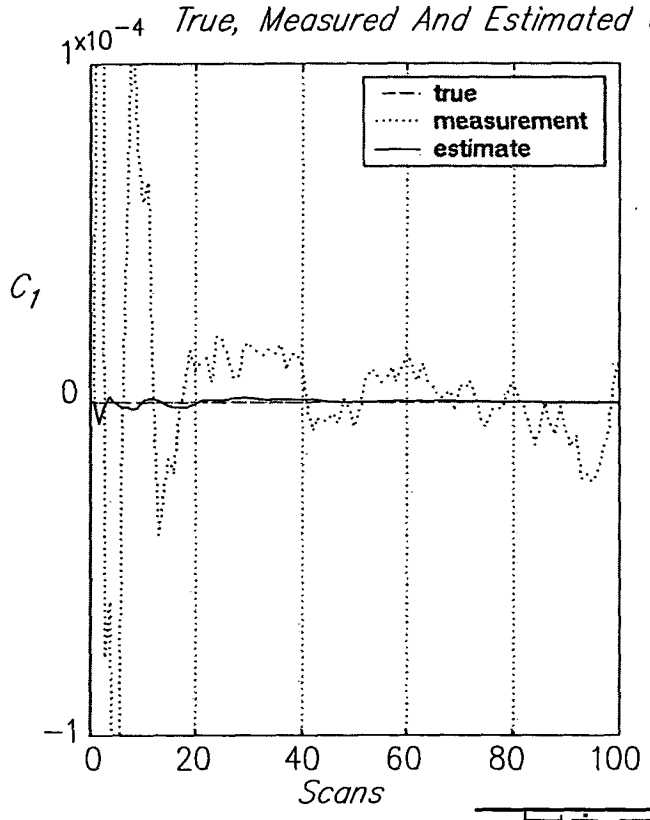

Fig. 10d.

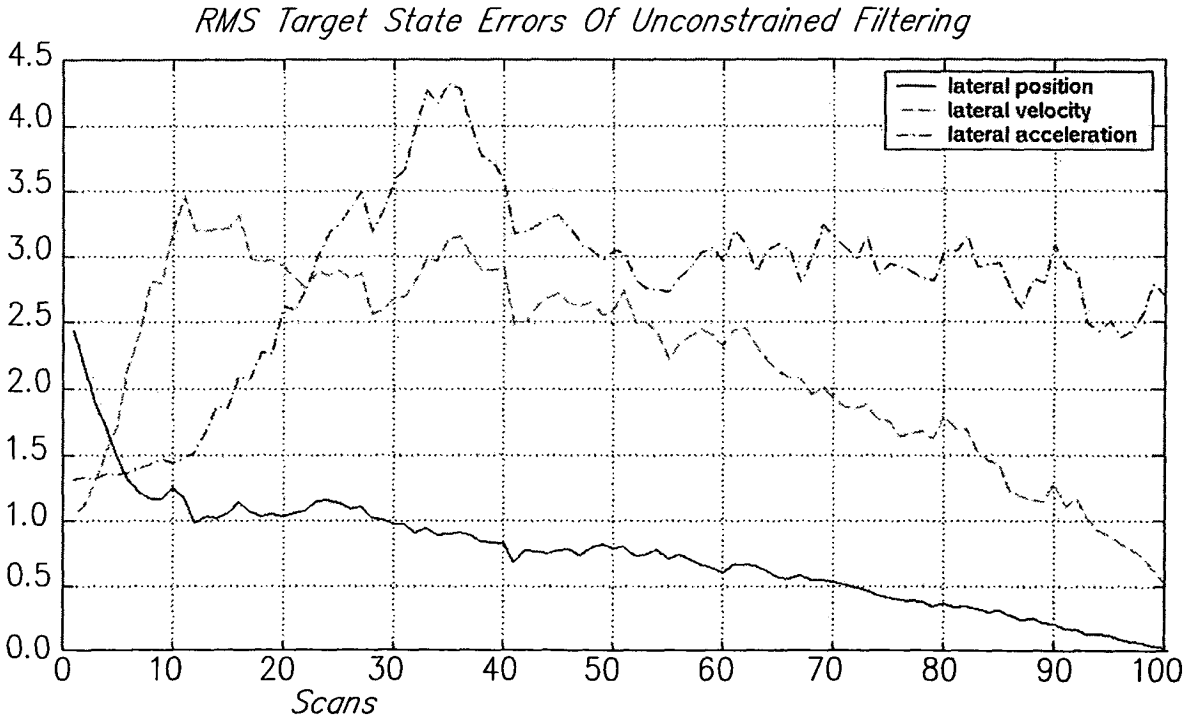

Fig. 11a.

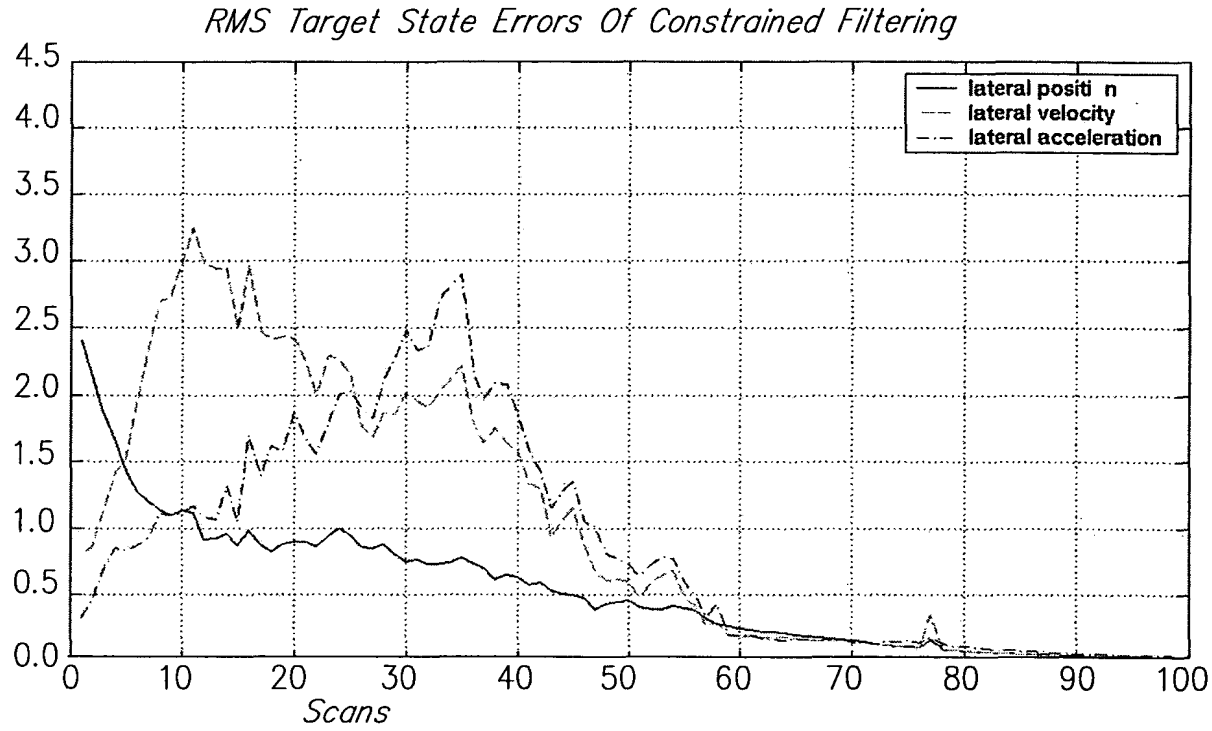

Fig. 11b.

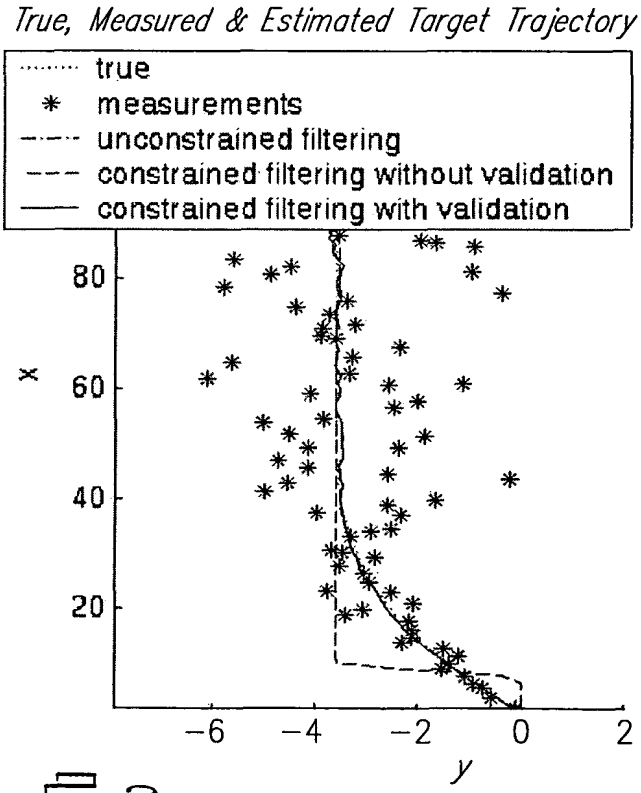

Fig. 12a.

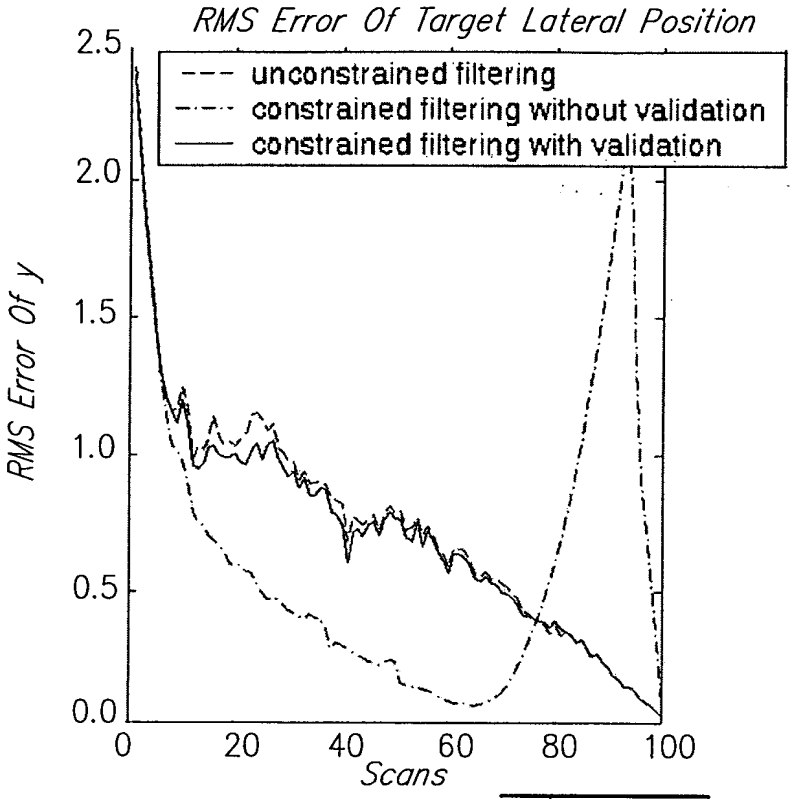

Fig. 12b.

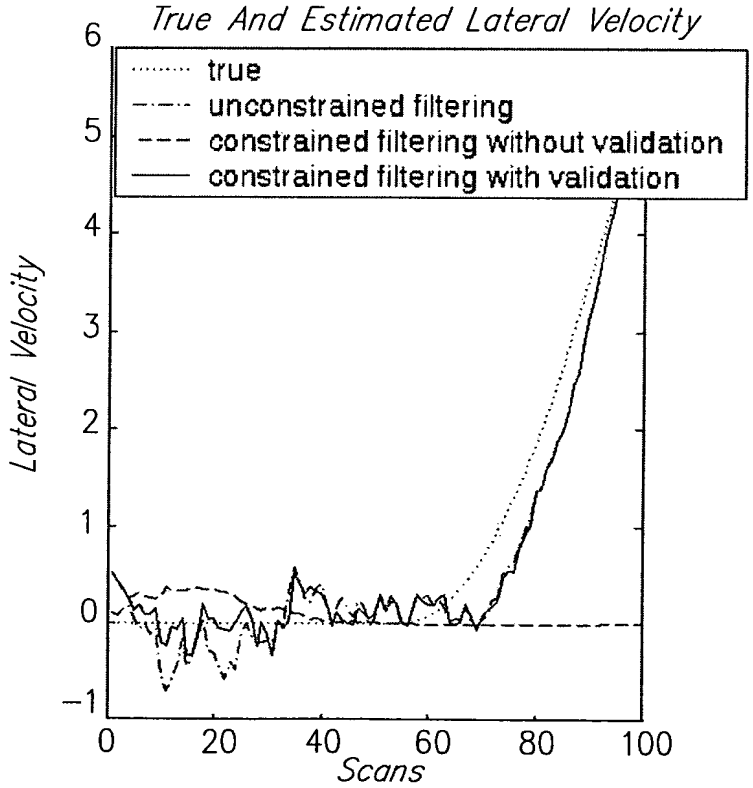

Fig. 12c.

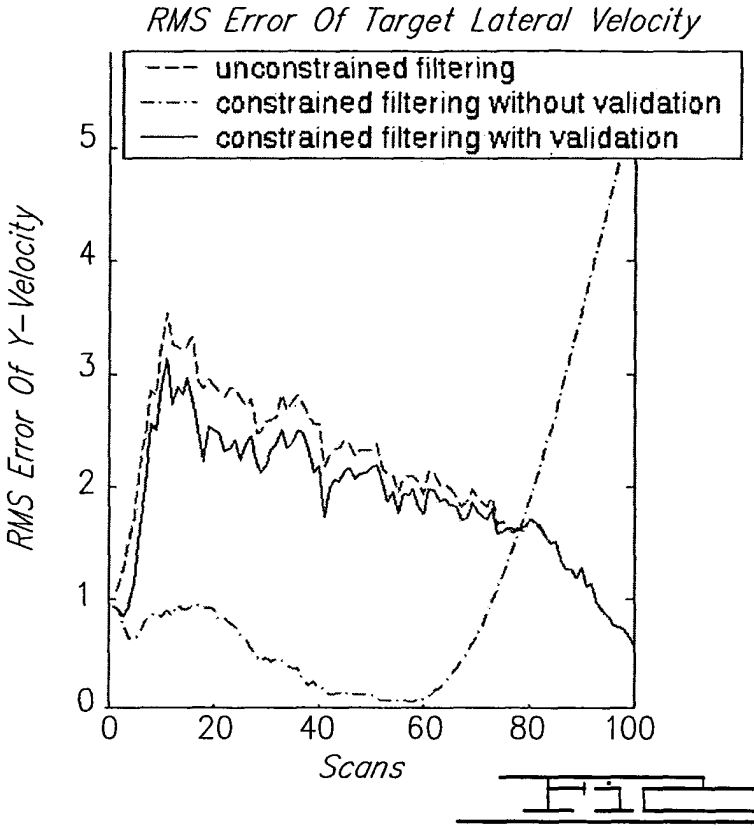

Fig. 12d.

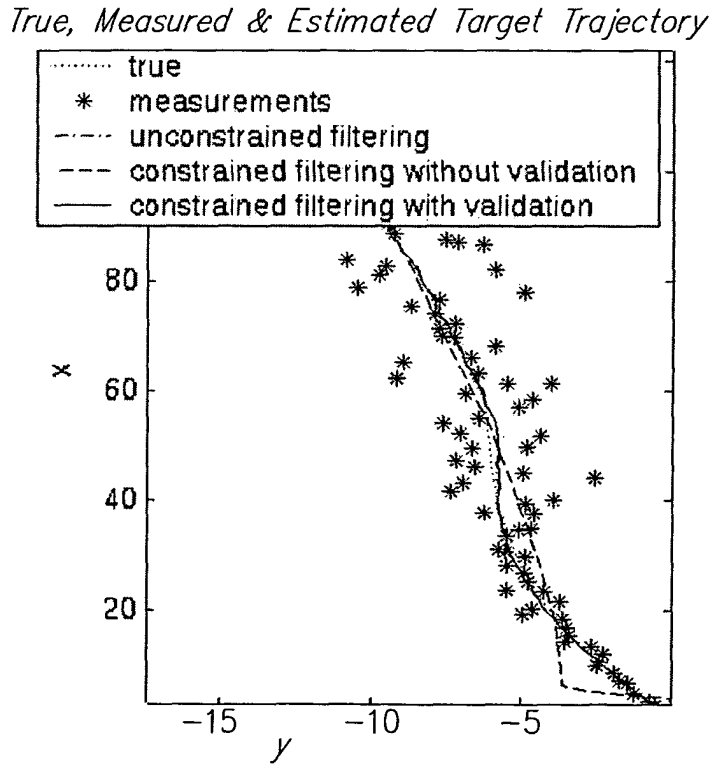

Fig. 13a.

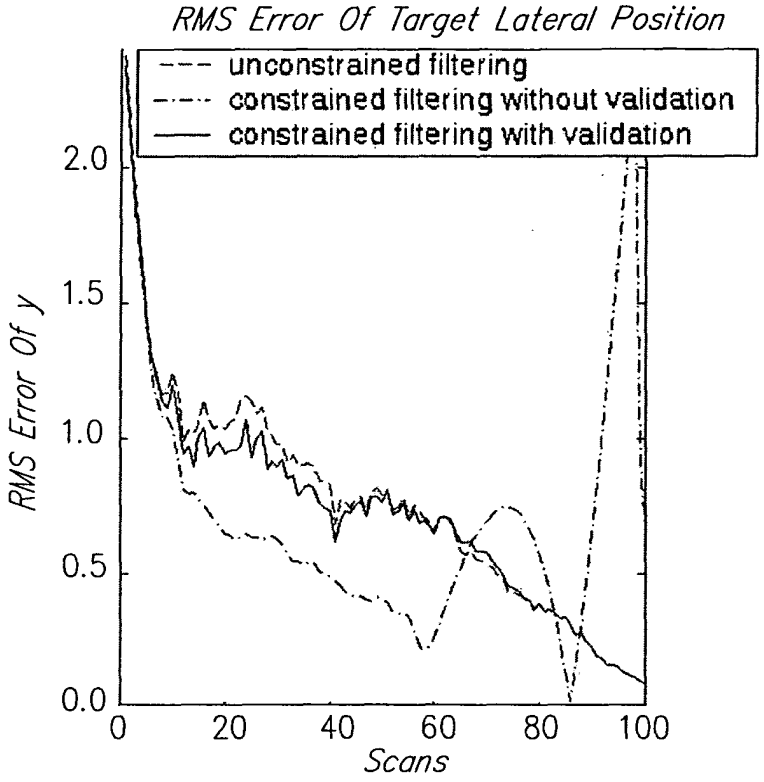

Fig. 13b.

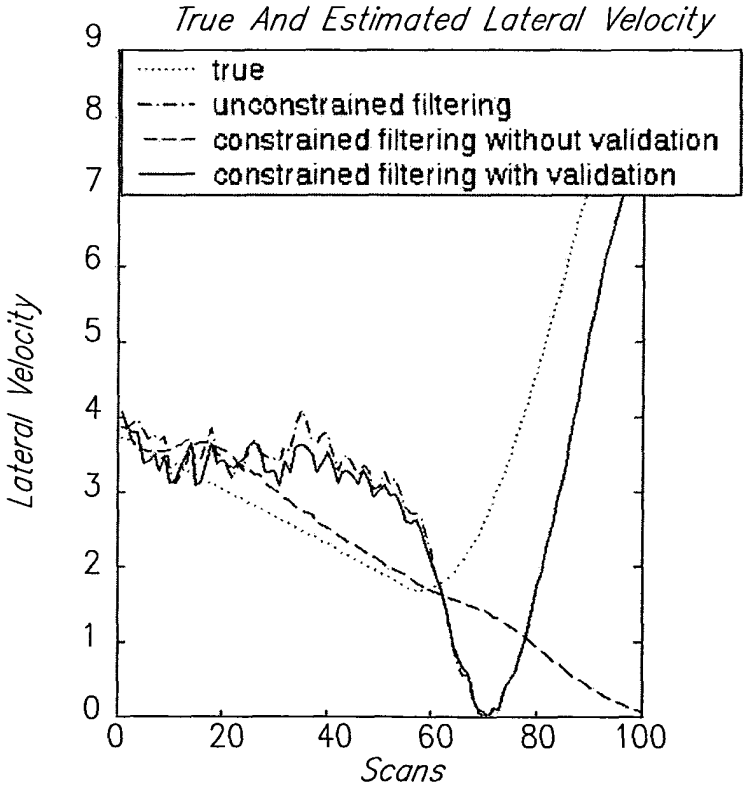

Fig. 13c.

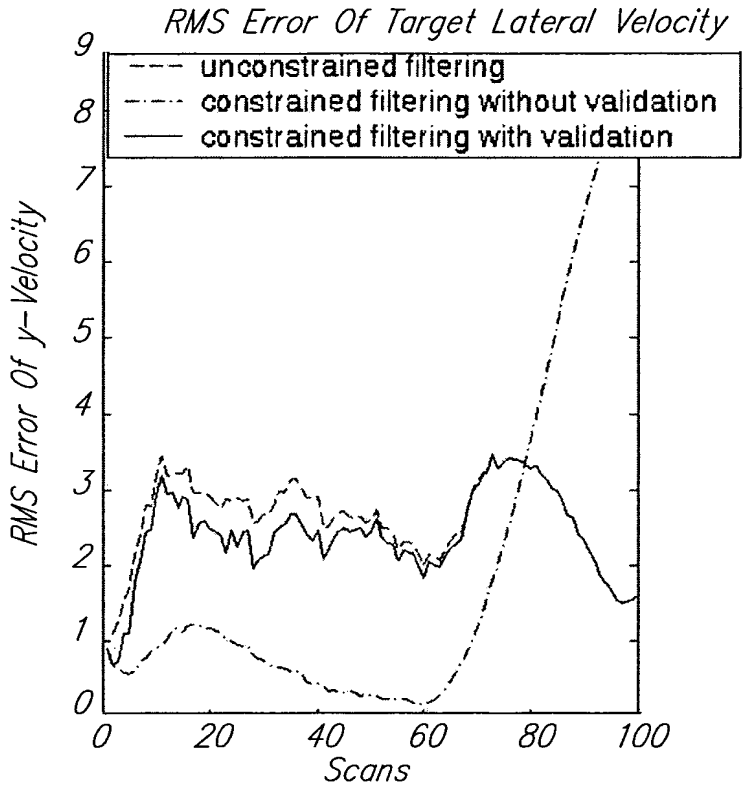
RMS Error Of Target Lateral Velocity
unconstrained filtering
constrained filtering without validation
constrained filtering with validation
RMS Error Of y-Velocity
Scans
0
1
2
3
4
5
6
7
8
9
0
20
40
60
80
100

Fig. 13d.